# Rotational speed sensor KMI10/4

## FEATURES

- Digital current output signal
- Zero speed capability
- Wide air gap
- Wide temperature range
- Vibration insensitive
- EMC resistant.

## DESCRIPTION

The KMI10/4 sensor detects rotational speed of ferrous gear wheels and reference marks(1). The sensor comprises a magnetoresistive sensor element, a signal conditioning circuit in bipolar technology and a ferrite magnet. The frequency of the digital current output signal is proportional to the rotational speed of a gear wheel.

(1) The sensor contains a customized integrated circuit. Automotive Anti Blocking Systems (ABS) applications are restricted, other applications are free.

## PINNING

| PIN | DESCRIPTION |
|---|---|
| 1 | $V_{CC}$ |
| 2 | V– |

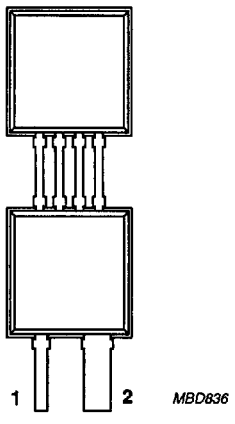



Fig.1 Simplified outline.

## QUICK REFERENCE DATA

| SYMBOL | PARAMETER | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|
| $V_{CC}$ | DC supply voltage | – | 12 | – | V |
| $T_{amb}$ | operating ambient temperature | –40 | – | +150 | °C |
| $I_{CC(low)}$ | output current low | – | 7 | – | mA |
| $I_{CC(high)}$ | output current high | – | 14 | – | mA |
| $f_{t(oper)}$ | operating tooth frequency | 0 | – | 25000 | Hz |
| d | sensing distance | 0 to 2.0 | 0 to 2.3 | – | mm |

## FUNCTIONAL DESCRIPTION

The KMI10/4 sensor is sensitive to the motion of ferrous gear wheels or reference marks. The functional principle is shown in Fig.3. Due to the effect of flux bending, the different directions of magnetic field lines in the magnetoresistive sensor element will cause an electrical signal. Because of the chosen sensor orientation and the direction of ferrite magnetization, the KMI10/4 is sensitive to movement in 'y' direction in front of the sensor only (see Fig.2). The magnetoresistive sensor element signal is amplified, temperature compensated and passed to a Schmitt-trigger in the conditioning IC (see Figs 4 and 5). The digital output signal (see Fig.6) is at a fixed level independent of the sensing distance. A (2-wire) output current ensures safe sensor signal transport to the detecting circuit (see Fig.7). The IC housing is deliberately separated from the sensor element housing to optimize the sensor behaviour at high temperatures.

The strength of the magnetic field caused by the Ferroxdure 100 magnet in the different sensor directions, measured at the centre of the magnetoresistive bridge, is typically: $H_x$ = 7 kA/m (auxiliary field) and $H_z$ = 17 kA/m (perpendicular to the sensor surface). $H_y$ is zero due to the trimming process.

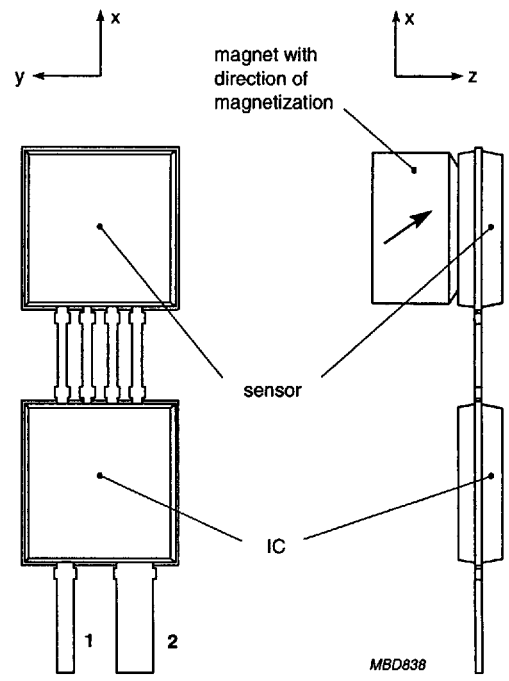



Fig.2 Component detail of the KMI10/4.

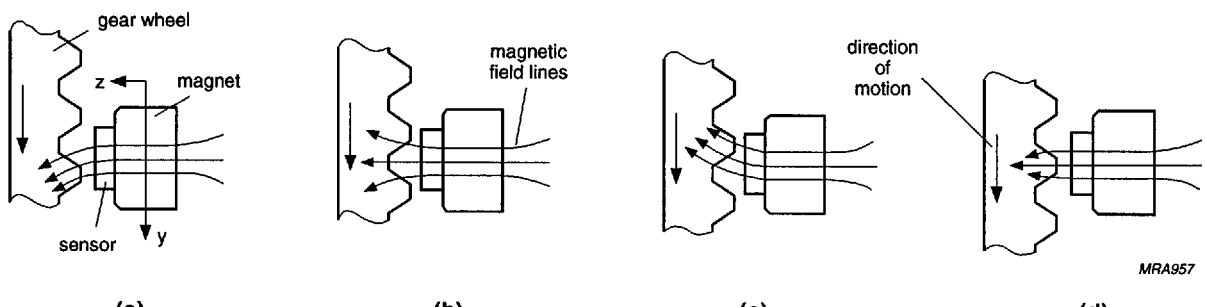



Fig.3 Functional principle.

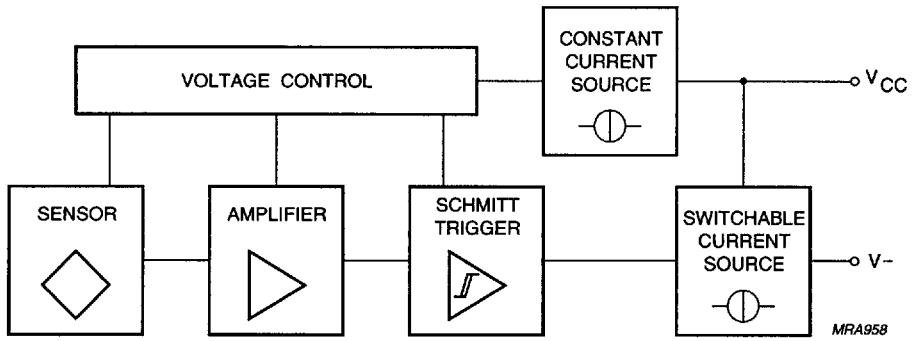



Fig.4 Block diagram.

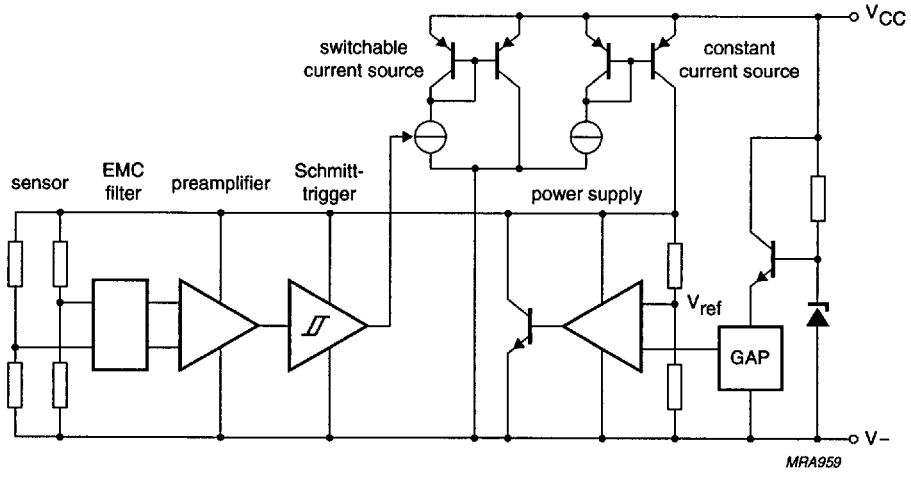



Fig.5 Simplified circuit diagram.

## LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

| SYMBOL | PARAMETER | CONDITIONS | MIN. | MAX. | UNIT |
|---|---|---|---|---|---|
| $V_{CC}$ | DC supply voltage | $T_{amb}$ = –40 to +60 °C | 7.5 | 20 | V |
| | | $T_{amb}$ = –40 to +150 °C | 7.5 | 16 | V |
| $T_{stg}$ | storage temperature | | –40 | +150 | °C |
| $T_{amb}$ | operating ambient temperature | | –40 | +150[1] | °C |
| $T_{peak}$ | peak temperature | sensor front only, 3 × 1 h over lifetime | – | 190 | °C |
| $T_{sld}$ | soldering temperature | t ≤ 10 s | – | 260 | °C |
| | output short-circuit duration to GND | | continuous, note 2 | | |

### Notes

1. The ambient operating temperature range of the module can be extended up to +175 °C for a limited time.
2. With $R_L$ = 115 Ω, the device is continuously protected against wrong polarity of DC supply voltage $V_{CC}$ to GND (see Fig.7).

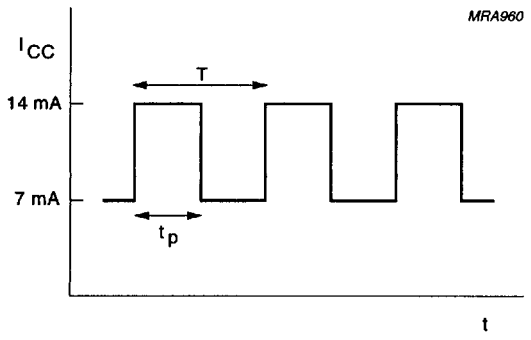
## CHARACTERISTICS

$T_{amb}$ = 25 °C; $V_{CC}$ = 12 V; d = 1.5 mm; f = 2 kHz; test circuit: see Fig.7; $R_L$ = 115 W; test arrangement: see Fig.15; gear wheel: module 2 mm; material 1.0715; unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| $I_{CC(low)}$ | output current low | see Figs 6 and 8 | 5.6 | 7 | 8.4 | mA |
| $I_{CC(high)}$ | output current high | see Figs 6 and 8 | 11.2 | 14 | 16.8 | mA |
| $t_r$ | output current rise time | $C_L$ = 100 pF; see Fig.9; 10% to 90% value | – | 0.5 | – | µs |
| $t_f$ | output current fall time | $C_L$ = 100 pF; see Fig.9; 10% to 90% value | – | 0.7 | – | µs |
| $t_d$ | switching delay time | between stimulation pulse (generated by a coil) and output signal | – | 1 | – | µs |
| $f_{t(oper)}$ | operating tooth frequency | for both rotation directions | 0 | – | 25000 | Hz |
| δ | duty cycle | see Fig.6 | 20 | 50 | 80 | % |
| d | sensing distance | see Fig.15; note 1 | 0 to 2.0 | 0 to 2.3 | – | mm |

### Note

1. High rotational speeds of wheels reduce the sensing distance due to eddy current effects (see Fig.17).




$$\delta = \frac{t_p}{T} \times 100\%$$

Fig.6 Output signal as a function of time.

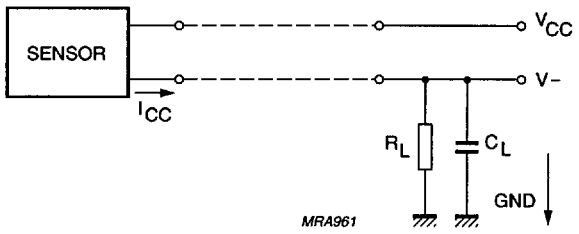



Fig.7 Test and application circuit.

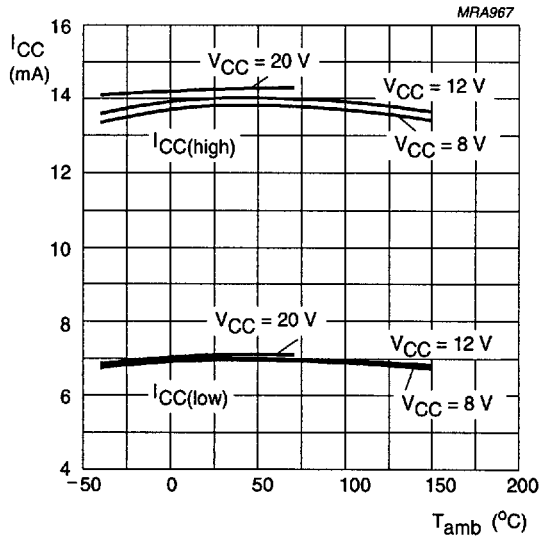



Fig.8 Output current levels as functions of ambient temperature.

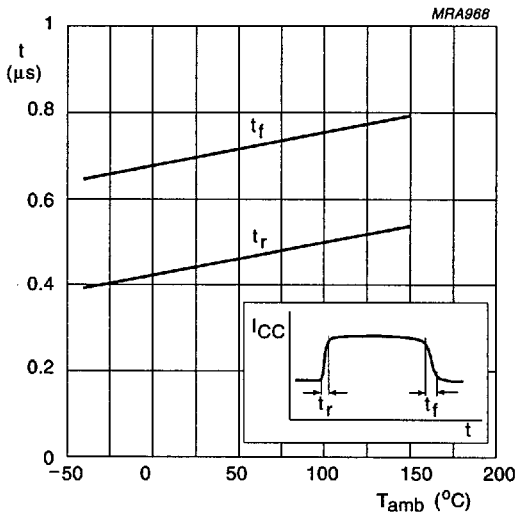



Fig.9 Output current switching times as functions of ambient temperature.

## APPLICATION INFORMATION

### Mounting conditions

The recommended sensor position in front of a gear wheel is shown in Fig.15. Distance 'd' is measured between the sensor front and the tip of a gear wheel tooth. The KMI10/4 senses ferrous indicators like gear wheels in ± y-direction only (no rotational symmetry of the sensor); see Fig.2. The effect of incorrect mounting positions on sensing distance is shown in Figs 11, 12 and 13. The symmetrical reference axis of the sensor corresponds to the axis of the ferrite magnet.

### Environmental conditions

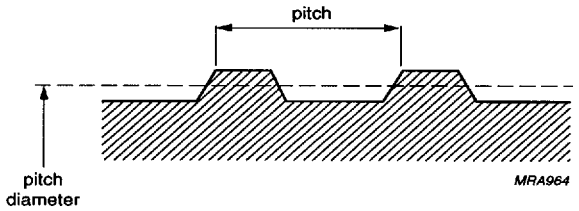
Due to eddy current effects the sensing distance depends on the tooth frequency (see Fig.17). The influence of gear wheel module on the sensing distance is shown in Fig.16.

### Gear wheel dimensions

| SYMBOL | DESCRIPTION | UNIT |
|---|---|---|
| **German DIN** | | |
| z | number of teeth | |
| d | diameter | mm |
| m | module m = d/z | mm |
| p | pitch = π × m | mm |
| **ASA**(1) | | |
| PD | pitch diameter (d in inch) | inch |
| DP | diameter pitch DP = z/PD | $inch^{-1}$ |
| CP | circular pitch CP = π/DP | inch |

**Note**

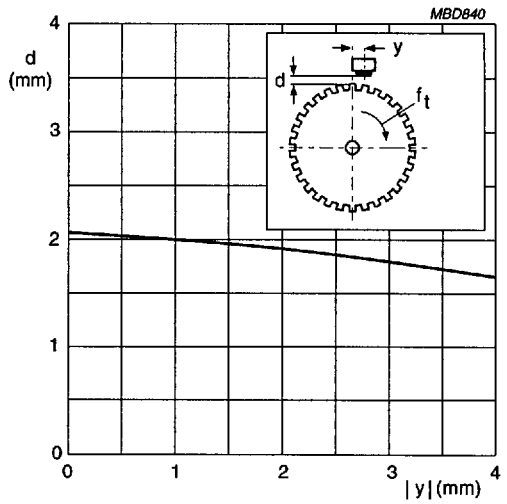
1. For conversion from ASA to DIN: m = 25.4 mm/DP; p = 25.4 mm × CP.




$$\text{module} = \frac{\text{pitch diameter}}{\text{number of teeth}}$$

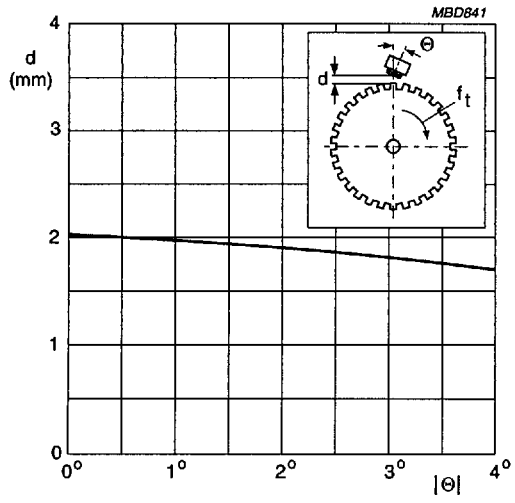
$$\text{pitch} = \text{module} \times \pi$$

Fig.10 Gear wheel definitions.



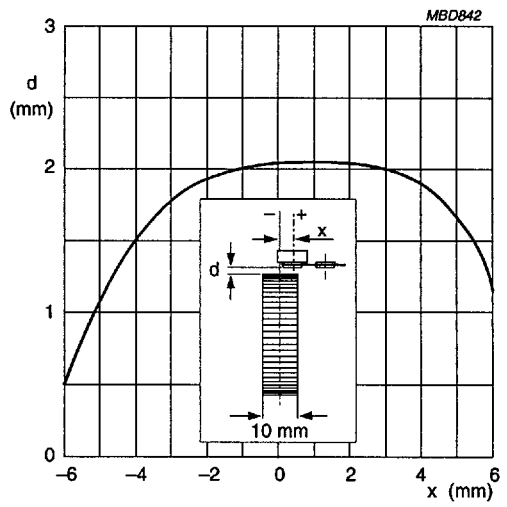

$V_{CC}$ = 12 V; $f_t$ = 2 kHz; module = 2 mm; pitch diameter = 100 mm.

Fig.11 Sensing distance as a function of positional tolerance in the y-axis.




$V_{CC}$ = 12 V; $f_t$ = 2 kHz; module = 2 mm.

Fig.12 Sensing distance as a function of positional tolerance.




$V_{CC}$ = 12 V; $f_t$ = 2 kHz; module = 2 mm.

Fig.13 Sensing distance as a function of positional tolerance in the x-axis.

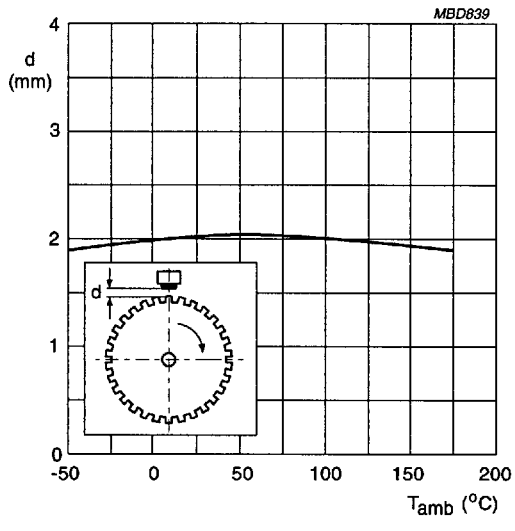



Fig.14 Typical sensing distance as a function of ambient temperature.

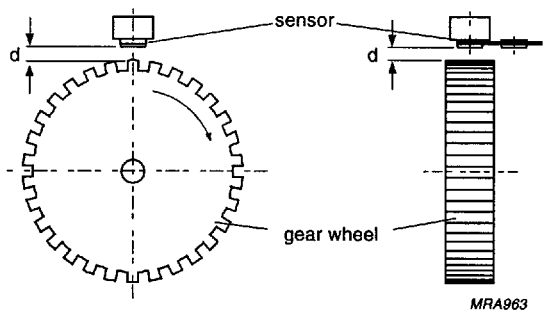
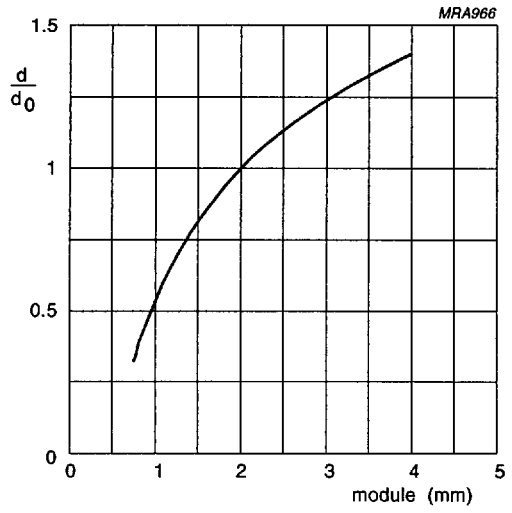
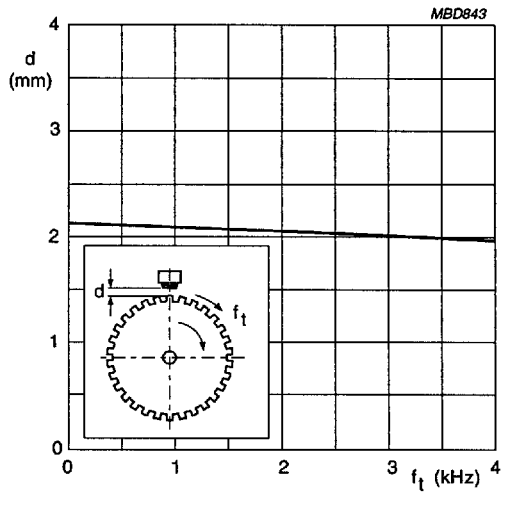



Fig.15 Sensor positioning.




$d_0$ = sensing distance for gear wheel with module = 2 mm.

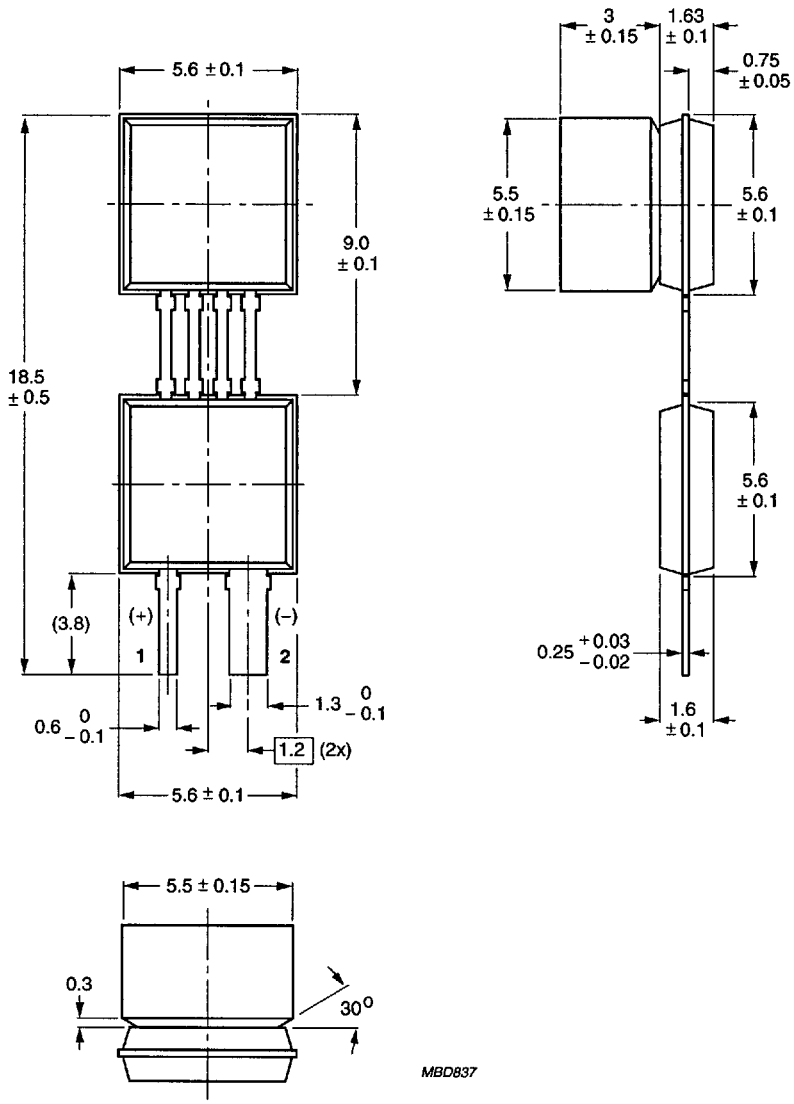
Fig.16 Normalized maximum sensing distance as a function of a gear wheel module.




$V_{CC}$ = 12 V; module = 2 mm.

Fig.17 Sensing distance as a function of tooth frequency.

## PACKAGE OUTLINE




Dimensions in mm.

Fig.18 Outline of KMI10/4.